ARTOPS

A Blackjack Playing Robot

100
Fasteners

1000+
Lines of Code

18
Laser-cut Panels

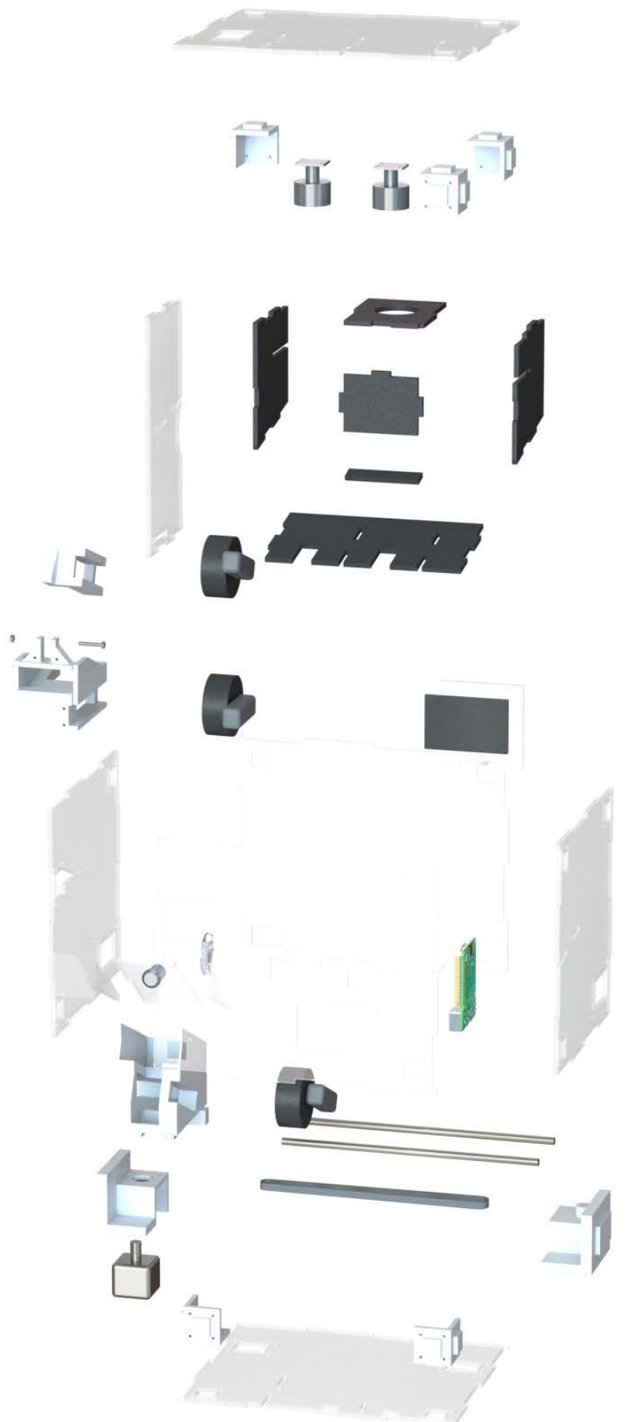
10
3D Printed Components

4
Electric Motors
(3 DC, 1 Stepper)

2
Microcontrollers

2
Cameras

1
Capacitive Touch Display



By Patrick McGuckian & Oliver Colebourne

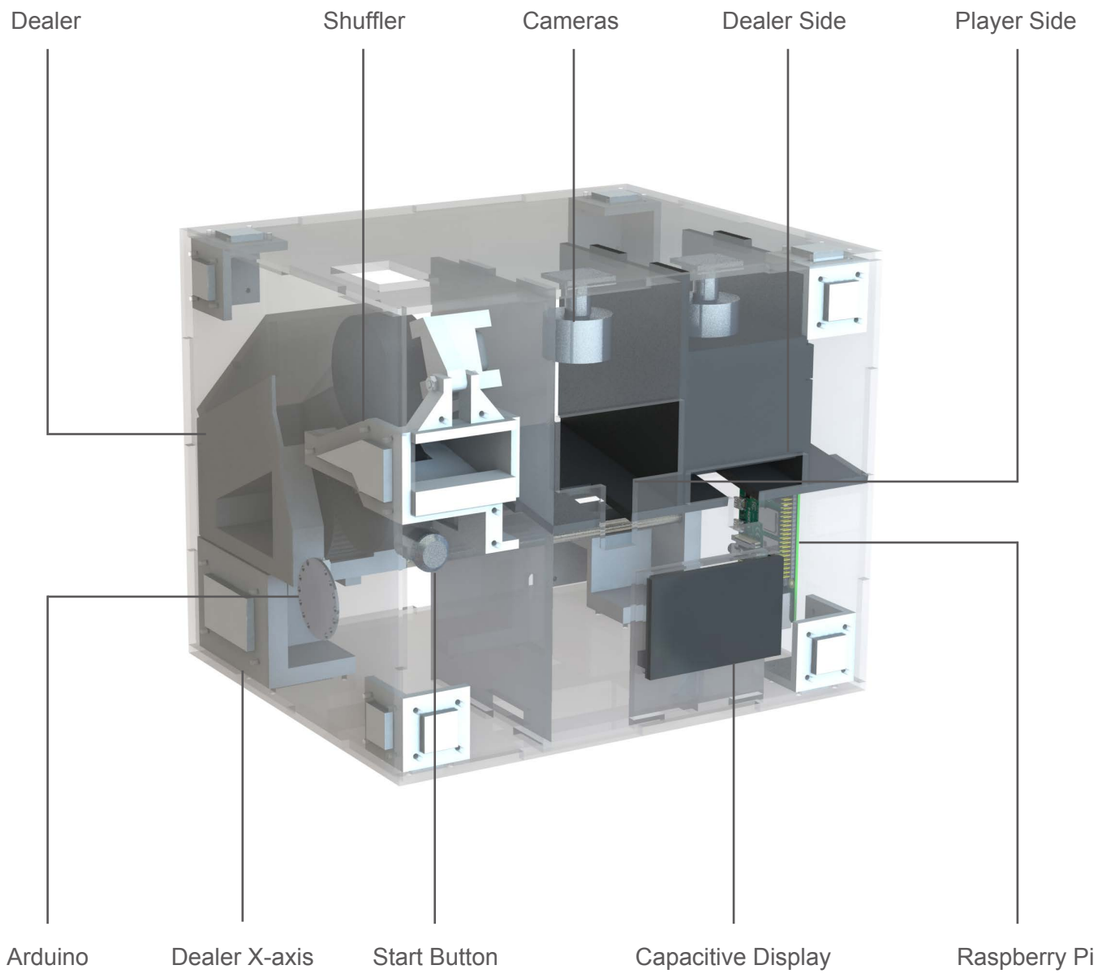
Introduction

ARTOPS

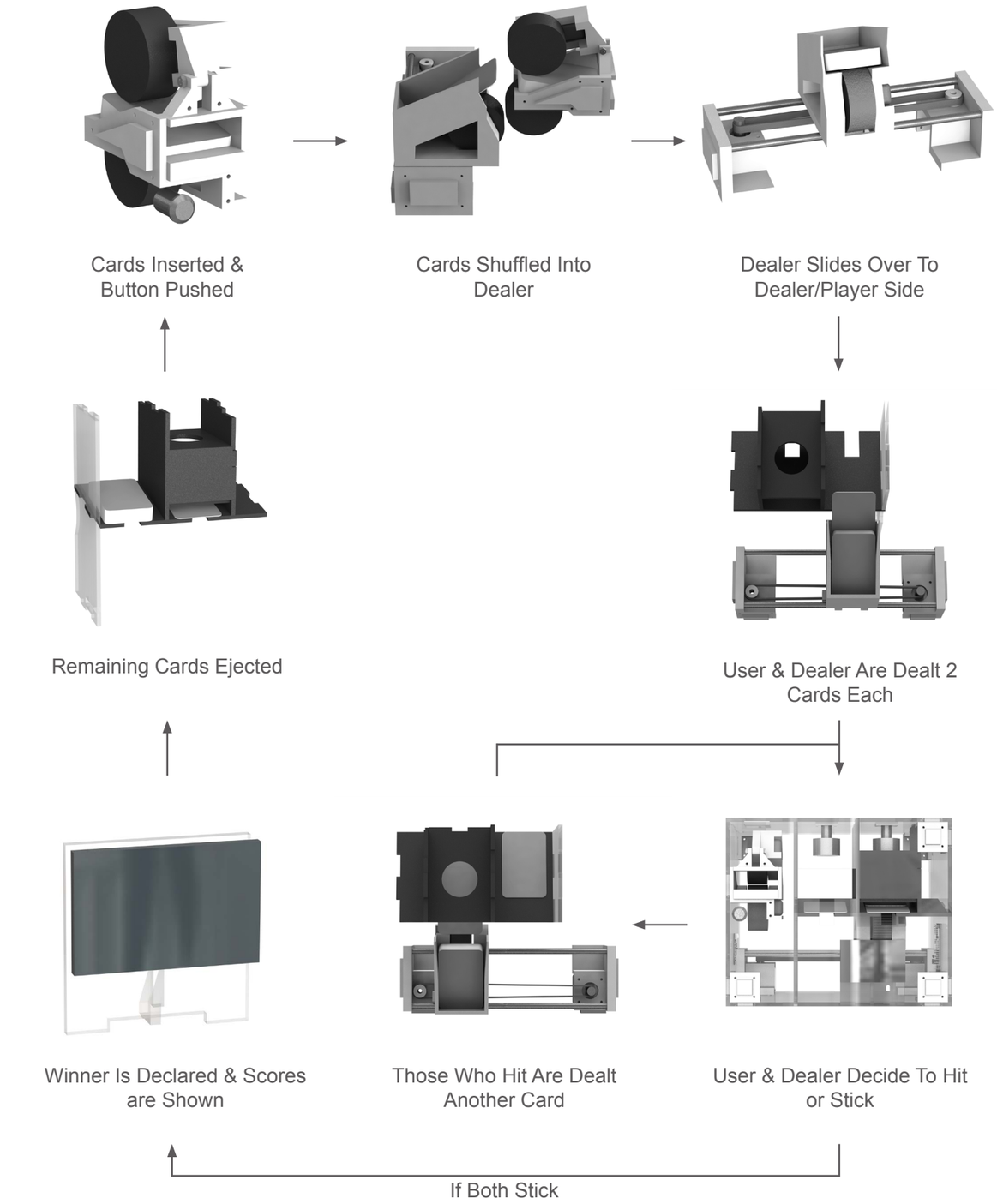
ARTOPS is a Blackjack playing robot. It acts as the dealer: shuffling, dealing, and keeping track of the cards - as well as choosing to hit or stick based on its own hand and communicating with the user throughout.

It is built around a Raspberry Pi Model 3B+ and its user interface is coded in Python using the PyQT5 module. The Pi is responsible for dealing and reading the cards, and it communicates with an Arduino to shuffle them.

Product Diagram



Game-play Overview



Mechatronics

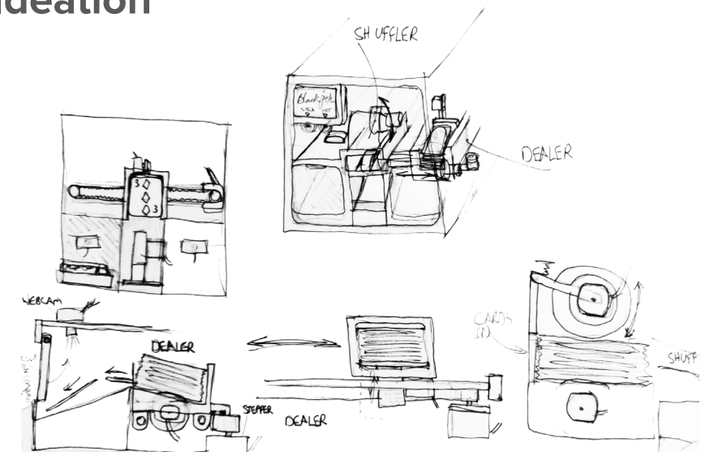
The Process

The game of Blackjack requires a dealer to shuffle and deal cards. We developed two separate mechatronic systems to complete these tasks.

Playing cards are thin and lightweight meaning they can be extremely difficult to reliably control, and our design required precise dealing and shuffling.

After initial sketching we built CAD models and 3D printed a number of prototypes, testing and iterating them until we had a reliable system.

Ideation



Prototyping

Shuffling Cards

1

Concept:
The cards sit between two wheels with the top hinged to always touch the deck. The top or bottom wheel spins randomly 52 times - each time firing a card onto the dealer below.

Issues:
The cards were being shot out the slot and bottom wheel was moving the entire deck.

2

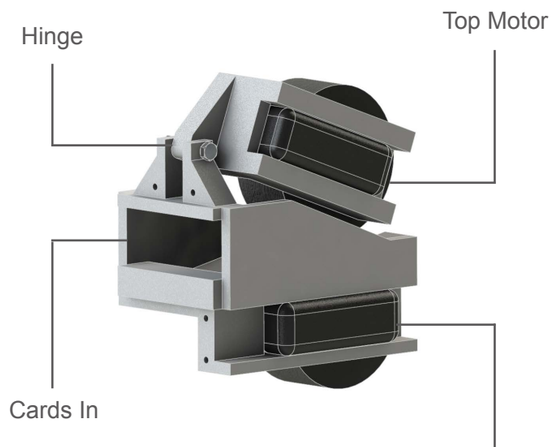
Iteration:
The card bed was angled at 20 degrees and the software changed so that after each card the wheel spins in reverse to pull the following card back.

Issues:
Cards fired from the bottom weren't making it over the edge onto the dealer below & the final few cards were getting stuck.

3

Iteration:
The bottom motor was moved forward and the software changed so it finished by spinning both wheels at the same time.

Issues:
The design needed changing so it could be fitted to the final product by including screw holes and embossed sections.



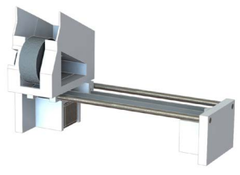
Dealing Cards To Player & User

1

Concept:
The card dealer sits on-top of the x-axis and is moved between the shuffler and the player & dealer sides using a stepper and belt. Cards are dealt by spinning a wheel underneath them.

Issues:
Card bed was too short to hold the full deck; and metal rods didn't fit x-axis sides.

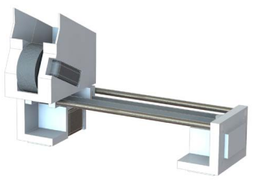
2



Iteration:
The sides of the card bed were raised and angled to help guide shuffled cards in. The x-axis rod holes were widened and slider mounts were included.

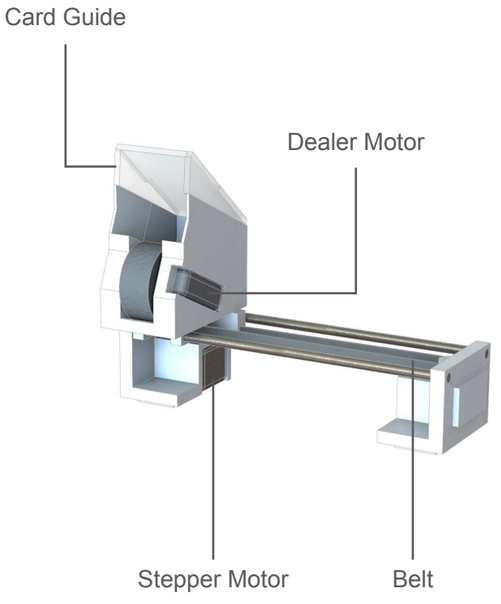
Issues:
Dealer wheel was brushing against its housing and the motor stuck out too far for dealer to slide flush with casing.

3



Iteration:
The dealer motor was moved onto the other side of the dealer; and the clearance for the motor wheel was increased. Additions were also made to the design for assembly.

Issues:
Cards weren't falling from the shuffler onto the bed consistently.

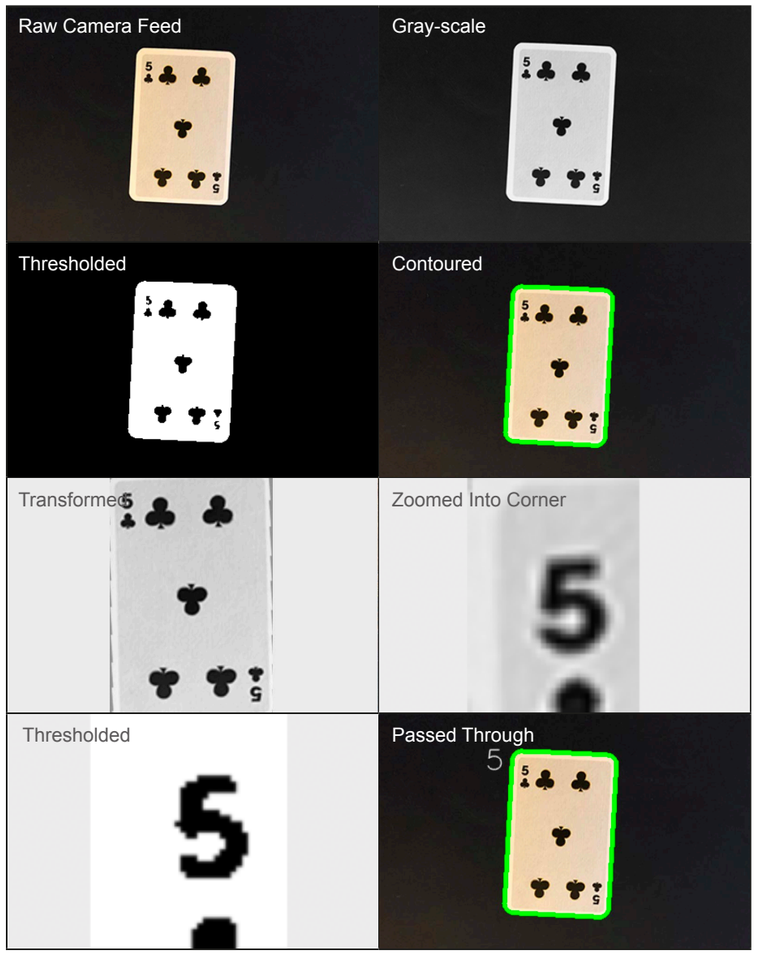


Software

Reading Card Ranks

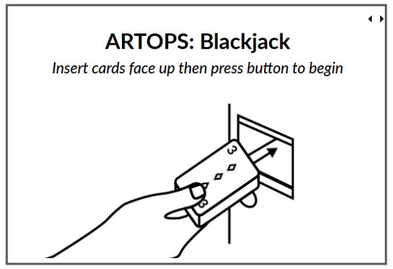
To act as the dealer, ARTOPS needed to be able to track the values of both the players and its own hand. We did this by placing cameras above the player and dealer cards and designing a custom computer vision system (Keras & OpenCV) to read the cards.

It works by isolating the top left corner of the card and passing it through a neural network to give a prediction. It repeats this process 25 times and returns the most common result as the predicted card rank.



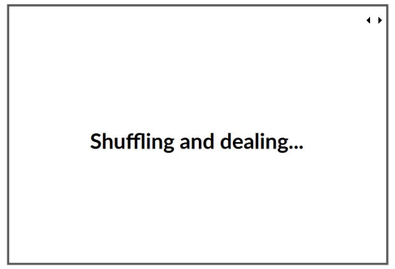
Running The Game

1



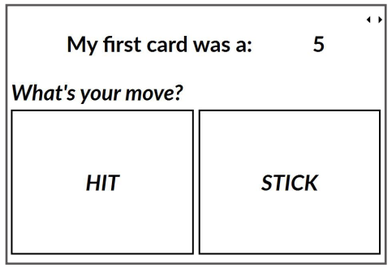
1. Wait for Button Press:
   - Continue To 2

2



1. Serial Communicate To Arduino To Start Shuffle
2. Wait For Confirmation From Arduino
3. Dealer Moves To Player & Dealer Sides
4. Dealer Deals Player & Dealer 2 Cards
5. Computer Vision Records Card Values

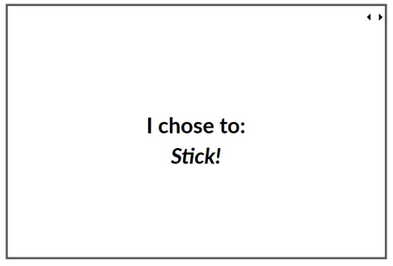
3



1. If ‘Hit’:
   - Deal User A New Card
   - Computer Vision Records Card Value
   - Continue To 4

   If ‘Stick’:
   - Continue To 4

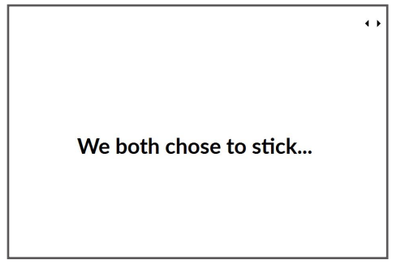
4



1. Works Out Average Value Of Cards Remaining In Deck
2. If Average + Current Score < 21:
   - It Deals Itself Another Card

   Else:
   - Continue To 4

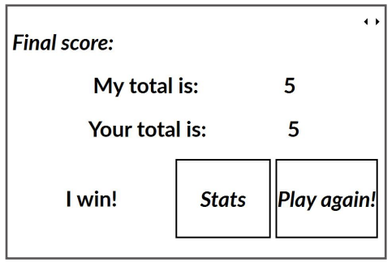
5



1. If Both User & Dealer Choose Stick Or Dealer Score Or Player Score > 21:
   - Continue To 6

   Else:
   - Continue To 3

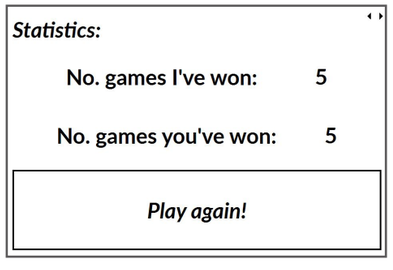
6



1. Decide Who Won Game & Update Stats Text File With Result
2. If ‘Stats’:
   - Continue to 7

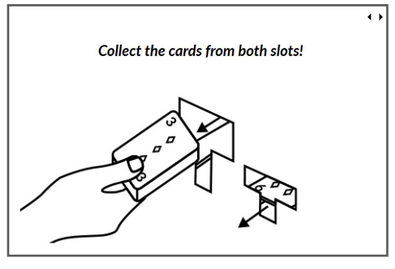
   If ‘Play Again’:
   - Continue to 8

7



1. Read Stats Text File
2. Wait for Play Again:
   - Continue to 8

8



1. Move Dealer To Player Side
2. Spin Dealer Motor For 8 Seconds To Eject Cards
3. Dealer Moves To Shuffler
4. Continue to 1

Design

White 3D Printed Components

We 3D Printed all of our internal components to make sure the tolerances were as low as possible. The components used for assembly have 5mm embossed sections that fit precisely into holes cut into the casing, to make sure the fit is as tight as possible.

Components Are Structural

To make is easy to see what's happening inside we wanted as few internal components as possible. So we designed the dealer slider and the shuffler to be part of the assembly of the casing rather then simply screwed onto it.

A Physical Button

We wanted a tactile interaction with the device so it is started with the press of an inviting glowing mechanical button.

Mechanical Fasteners

We wanted to avoid using glue to assemble our casing - so we used machine screws to hold it together.

Ergonomic Card Collection Slots

Raised front stops cards from sliding off the bed while center slots allow for the player to easily lift cards out

Sheathed Cables

As the inside of the device visible we needed to make it as tidy as possible. So we sheathed the cables all of the cables.

Transparent Laser Cut Casing

We wanted the user to be able to see the internal workings of ARTOPS so we made the casing of the product transparent.

Hidden Dealer Cards

We covered the dealers cards from the user to keep the suspense of traditional card games.

Prototyped Circuit Boards

We wanted to emphasise the mechatronics and hide the electronics so we built our circuits using prototyping PCBs.